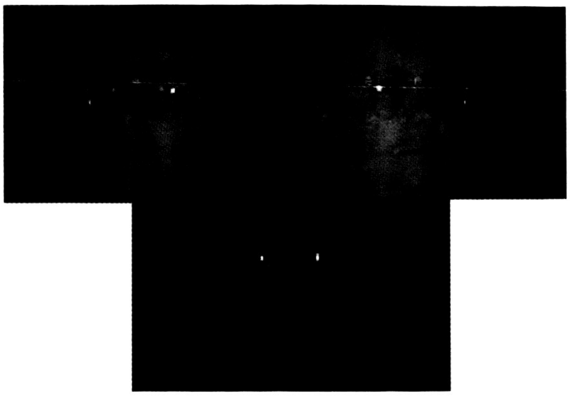

Fig. 2. The automated PERCLOS system captures two infrared images of the eye using a small camera with associated optics mounted in the flight deck. The two images are processed and reduced to a single image which is evaluated online for degree of eyelid closure.

vigilance performance, subjective sleepiness, continuous brain wave activity (electroencephalography, EEG), and continuous eye movement activity (electrooculography, EOG) were collected throughout the flight.

A PERCLOS-based alertness monitoring technology on the flight deck has potential as an on-line noninvasive alertness system for pilots who may encounter challenges in high homeostatic drive and circadian rhythm disruption. An on-line, human-centered, objective monitoring technology may be used as a backup for crew members who have integrated in-flight napping or activity break policies in their standard operating procedures. This type of technology can also potentially be implemented in environments that have fewer than three crew members during flight operations.

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Evaluating Stereo Displays for Manual Control

Mary K. Kaiser and Barbara Sweet

The current study was conducted to evaluate the relative benefits of stereo presentation versus higher update rates for controlling simulated vehicle motion. Visual displays are used to convey critical control information to pilots of aircraft and space vehicles. Recent developments in display technology enable the use of stereo displays, but these displays incur significant costs. In addition to increasing the complexity of system hardware and software, stereo necessarily decreases the spatial or temporal resolution of the display, since the two required fields (one for each eye) must be interlaced temporally or spatially. In the past, analysis tools were developed to examine which visual cues are required to support manual control tasks. This year, we applied this tool to determine whether stereo displays improved operators' control of motion in depth (as in a docking task), given that stereo halves the update rate of the display.

The model of the depth control task is shown in Figure 1. It was previously demonstrated that stereo disparity provides a more useful cue for position than for motion, leading to the prediction that stereo would prove more useful when operators control vehicle rate (i.e., change in position) than acceleration (i.e., change in motion). In the experiments, pilots performed both kinds of control tasks while viewing either stereo or non-stereo displays at two different update rates.

Results indicated that pilots performed significantly better with stereo on the rate-control task, but gained no benefit from stereo on the

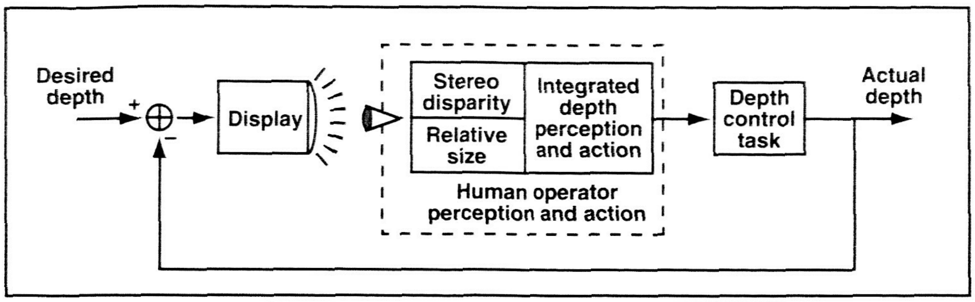

Fig. 1. Model of an operator depth control task.

acceleration-control task. As can be seen in Figure 2, operators had smaller errors (as measured by depth rms) with stereo displays in the rate control task (top panel), but not in the acceleration control task (bottom panel). These findings validated the model's predictions and the utility of the analysis tools.

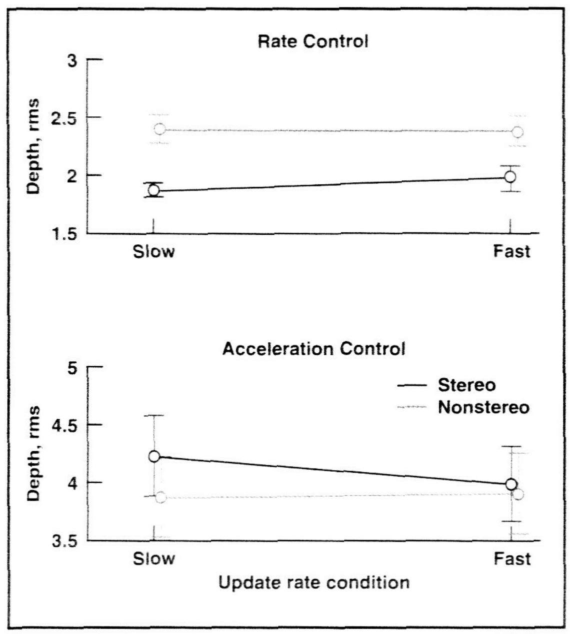

Fig. 2. Pilots' control performance on Rate Control (top panel) and Acceleration Control (bottom panel) tasks.

The research provides an effective demonstration that the specification of critical visual cues is task specific. Thus, display designers need to consider the nature of the operators' task in order to make an intelligent selection of visual interface parameters. The design issue is not to determine whether or not stereoscopic displays are useful, but rather to determine where and when stereo provides control information more effectively than other types of cues. The analysis tools support such determinations, for stereo as well as other display parameters (e.g., update rate, resolution, contrast), enabling designers to optimize displays for specific missions.

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